THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY

Published by the Wilson Ornithological Society

VOL. 90, NO. 2 JUNE 1978 PAGES 159–334

Wilson Bull., 90(2), 1978, pp. 159–181

A REVISION OF THE MEXICAN *PICULUS* (PICIDAE) COMPLEX

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The neotropical woodpeckers of the genus *Piculus* are closely related to the flickers (*Colaptes*) (Short 1972). *Piculus* species range from Mexico to southern Brazil, Paraguay, Peru (Ridgway 1914) and Argentina (Salvin and Godman 1892). Peters (1948) lists 46 taxa (9 species and their subspecies) of which 20 are subspecies of *Piculus rubiginosus*, the most widely distributed species. The latter ranges from southern Veracruz to the northwestern provinces of Jujuy, Salta, and Tucuman in Argentina (Peters 1948).

Compared with other picids, this genus is generally poorly represented in museum collections. It is possible that they are not as rare as they seem, but being rather silent and secretive birds and difficult to distinguish from the associated vegetation due to their cryptic green coloration, are easily passed unnoticed by collectors in the field.

A difference of opinion exists among taxonomists regarding the status of several of the Mexican forms. Two species complexes are recognized in the Mexican check-list (Miller et al. 1957). The *Piculus auricularis* complex is reported by these authors as consisting of 2 subspecies: *sonoriensis* known only from the type series of 3 birds taken at Rancho Santa Barbara, Sonora, and the nominate race *auricularis* recorded as ranging from Sinaloa south to Guerrero. They point out the uncertain status of the form *sonoriensis*, stating that additional material is needed to substantiate it. In their treatment, the *Piculus rubiginosus* complex in Mexico is subdivided into 3 subspecies: *aeruginosus*, *maximus*, and *yucatanensis*. Other authors have treated *aeruginosus* as a full species (Ridgway 1914, Peters 1948, Sutton 1951, Blake 1953, Peterson and Chalif 1973, Gehlbach et al. 1976). Wetmore (1941) questioned the status of *maximus* stating that "the systematic understanding of the species *rubiginosus* is at present unsatisfactory. In Mexico and Central America these birds seem subject to much individual variation, and I am inclined to believe that too many races have been proposed." In discussing the status of *yucatanensis*, Miller et al. (1957) point out that "all

specimens from high altitudes in the interior of south central Mexico require critical re-examination."

This study treats morphological variation in the Mexican *Piculus* complex and evaluates the status of the described forms. *Piculus auricularis* so far has proved to be allopatric in its geographical distribution with the *rubiginosus* complex. Several authors (Van Rossem and Hachisuka 1937, Sutton 1951, 1953) have pointed out the similarities existing between these species suggesting that they might actually be conspecific. Is the genus *Piculus*, therefore, represented by 1, 2, or 3 species in Mexico?

MATERIALS AND METHODS

Museum samples of *Piculus* (*rubiginosus*) *aeruginosus* and *Piculus rubiginosus yucatanensis* allopatric throughout most of their ranges were examined critically. Specimen material from central Veracruz was scrutinized for evidence of free interbreeding and intergradation which if present would justify the treatment of *aeruginosus* as a race of the *rubiginosus* complex, and if absent would warrant recognizing them as 2 distinct species. Material representing populations of *Piculus rubiginosus* in southern Mexico, namely in Oaxaca, Chiapas, and southern Veracruz, was analyzed, and the validity of the races *yucatanensis* and *maximus* evaluated.

For simplicity's sake the races of *Piculus rubiginosus* are referred to throughout this paper by their subspecific names *aeruginosus*, *yucatanensis*, and *maximus*. Similarly the races of *Piculus auricularis* are referred to as *auricularis* and *sonoriensis*. Some 238 skins from Mexico were considered in this study: 68 of *Piculus auricularis*, 81 of *aeruginosus*, 33 of *yucatanensis*, and 56 of *maximus*. In addition, 13 skins of *yucatanensis* from Honduras were examined. Localities from which samples were examined are illustrated in Fig. 1.

Measurements were taken of bill length (from nostril), tarsus, and chord of wing as described by Baldwin et al. (1931). Except when otherwise mentioned, one-tailed t-tests were conducted to test for differences between adjacent samples.

ECOLOGY AND LIFE HISTORY NOTES

Short (1973) has called attention to the paucity of information regarding the biology of *Piculus* species. I have, therefore, brought together the scanty literature on the natural history of the Mexican forms, which, hopefully, may prove useful to investigators intending to carry on field work on this group.

In the northernmost part of its range in Sonora, *Piculus auricularis sonoriensis* is known only from its type locality in the Upper Sonoran Zone at 1500 m elevation (Van Rossem 1945). Vegetation found in this life zone is discussed in Orr (1966:274). Elsewhere in its range it is a bird of pine-oak, pure oak, or oak-tropical deciduous forest. Specimens I examined were taken in pine-oak as high as 1970 m in Babizos, Sinaloa, to as low as 900 m in oak woodland near Tepic, Nayarit. To my knowledge it has never

FIG. 1. Map of Mexico showing localities from which samples of Mexican *Piculus* were examined.

been taken in the thorn scrub of coastal western Mexico. Much forest land has been cleared for cultivation; if abandoned, fallow land is invariably invaded by thorn scrub so that *Piculus* habitat is fast decreasing. In the southernmost part of its range in the Sierra de Miahuatlan, Oaxaca, the nominate *auricularis* has been taken in a greater variety of habitats such as boreal forest at 2650 m, cloud forest at 1500–2100 m, oak-tropical deciduous forest at 770 m, and humid tropical evergreen forest at 740 m. Habitats in these collecting localities are described in detail by Rowley (1966). The species probably occupies similar habitat in Guerrero (see vegetation map in Leopold 1959).

The Mexican *Piculus*, like others of this genus, in general are rather silent and secretive birds. The chief distinguishing feature between *Colaptes* and *Piculus* is the latter's silent nature (Short pers. comm.). There seems to be nothing in the literature concerning the vocalizations of *Piculus auricularis* or its nesting habits. Schaldach (1963) comments on the "apparent rarity"

of this species, suggesting that this may be due to its being very widely distributed, each individual covering a larger territory than those held by other woodpecker species.

Piculus rubiginosus aeruginosus has been taken in pine-oak 1500–2100 m in Nuevo Leon and in tropical forest in Gomes Farias, Tamaulipas (Sutton and Pettingill 1942). C. C. Lamb (unpubl. field notes, Moore Laboratory of Zoology) took a series of this form 24 km southwest of Linares, Nuevo Leon, where the habitat consisted of white and live oaks with mesquite trees forming an understory. This bird was also found to be fairly common in the canyon bottoms of the Sierra de Tamaulipas below 600 m and occasionally in pine-oak woods at 900 m (Martin et al. 1954). At La Joya de Salas, Tamaulipas, it was mainly a bird of deciduous woodland (Robins and Heed 1946). C. C. Lamb (unpubl. field notes) took this form on cottonwoods at the Rio Corona, 25 km north of Ciudad Victoria, Tamaulipas. There the vegetation consisted of sizeable trees intermixed with various cacti and mesquite trees. In the southern part of its range at Huachinango, 360 m, near the Puebla-Veracruz line, Lamb (field notes) collected this subspecies in "dense jungle."

The subspecies *P. r. yucatanensis* is a bird of mesic conditions (Wetmore 1943:222), similar to *aeruginosus* in Puebla and Veracruz. In the rainforests of the Catemaco Basin of Veracruz, it was found to be mostly a forest edge species (Edwards and Tashian 1959). At Cordoba, Veracruz, 270 m, Lamb (field notes) took this subspecies in heavily wooded mountains, described as a tangle of vines and bushes.

The subspecies *P. r. maximus* inhabits more open forest, such as the pine-oak and riparian tropical hardwood of the Monseratte Plateau (Edwards and Lea 1955). At Finca Cacahuatl, Chiapas, 19 km east of Tapanatepec, Oaxaca, Lamb (field notes) found this species in pine and oak forests at 808 m.

Dickey and Van Rossem (1938) found that *P. r. yucatanensis* fed exclusively on insects. They described its foraging behavior as working slowly up a tree and gently prying into crevices. Wetmore (1968) studied the species in Panama where he found that the diet included fruit. He observed a male eating a large blackberry. C. C. Lamb (field notes) observed a female *P. auricularis* eating berries off a madrone tree at Babizos, Sinaloa.

Piculus rubiginosus is very flicker-like in many of its habits such as in vocalizations (Dickey and Van Rossem 1938, Sutton 1951, 1953, Blake 1953, J. S. Rowley pers. comm.), its manner of perching (Sutton 1951), and its courtship behavior as observed by Sutton (1942, 1953). The last author reported seeing 3 or 4 birds together with spread wings and tail, bobbing and bowing to each other while calling excitedly. This activity was interrupted with brief periods of statuesque motionlessness. Group displaying is also

known in at least 2 species of flickers, the Andean Flicker (*Colaptes rupicola*) and the Campo Flicker (*C. campestris*) (Short 1972).

Nest holes have been found from 3.6–9 m off the ground in dead and live trees (Sutton 1953, Skutch 1969, Rowley pers. comm.). Clutch size appears to be 4 in *aeruginosus* (Robins and Heed 1951), *maximus* (Rowley pers. comm.), *uropygialis* (Skutch 1956), and *trinitatis* (Belcher and Smooker 1936). Rowley took a set of 4 eggs of *maximus* at Cerro Baul, Oaxaca, 1300 m, in a nest in the cavity of a dead tree, 15 m above the ground by a creek (HC 21387). Lloyd Kiff kindly provided egg measurements (mm) which are as follows: 23.91 × 19.10, 24.39 × 19.20, 24.60 × 18.92, 23.43 × 18.29.

The only detailed observations on nesting behavior of *P. rubiginosus* are those of Skutch (1943, 1948, 1956, 1969) which are here summarized. Non-nesting individuals roosted solitarily in holes. A male was observed joining a female in her roosting hole which was converted to a nest. Four eggs were observed resting on clean chips. Both sexes alternated on the eggs during the day, and the male incubated by night. Three hatched together, and 1 the next day. The young were pink-skinned and naked on hatching. Pinfeathers were first observed at 8 days. The parents removed waste matter from the nest only until the young were old enough to take food from the nest entrance at approximately day 21. Both parents fed the young. Only one of a brood of 4 observed survived. This was a female nestling which was flushed from the nest at day 24 and flew off. An adult male used the nest hole for roosting after the young had fledged. Young in their first plumage already had markings of adults of their own sex.

THE STATUS OF *Piculus auricularis sonoriensis*

The subspecies *sonoriensis* was described by Van Rossem and Hachisuka (1937) as grayer on pileum and back than the nominate, with "the upper back between the nape and dorsum prominently barred with grayish white." The type locality given was Rancho Santa Barbara, 1500 m, 31.7 km northeast of Guirocoba, situated at latitude 27° 16′ and longitude 108° 35′ (Van Rossem 1945).

The type and a topotype examined and compared with material from other parts of Mexico has led me to conclude that the gray coloration in the type description is of an adventitious nature rather than of genetic origin. The olive-green on the backs of *Piculus* is the result of the combined effect of 2 pigments distributed through 2 different components of the feathers. Beneath a dissecting microscope (10×) black pigment may be seen in the barbules, and yellow pigment in the rachis and barbs. Graying may be the result of any of a variety of causes such as feather wear, fading of yellow pigment due to exposure to light, to diet as suggested for *Colaptes* by Short (1965),

or the leaching effect of tannin from the barks of trees on which they forage as suggested for *Picoides stricklandi* by Davis (1965:573). Whatever the cause, graying as described for *sonoriensis* was also found in samples of *auricularis* from Nayarit and Oaxaca, as well as in several *rubiginosus*. The latter appeared darker due to heavier deposition of melanin pigment.

The second character mentioned by Van Rossem and Hachisuka, the barred upper back, was also found in series taken throughout the rest of the species' range. Moreover, a specimen taken in nearby Mount Mohinora in Chihuahua in October, in fresh fall plumage, was olive-green on the back as in *auricularis* from Sinaloa and Nayarit. The specimens from Sonora are, therefore, not subspecifically distinct at least from specimens taken in neighboring states such as Chihuahua, Sinaloa, and Nayarit as stated by these authors.

Birds from the northern states (Sonora to Colima) are larger than those from southern states (Guerrero and Oaxaca) (Figs. 2–4). Northern males have longer wings and bills and northern females have longer wings than do southern birds. Males of *sonoriensis* average 125 mm in wing length, and males of *auricularis* average 119.5 mm (one-sided $p < 0.00005$). Mean wing length of female *sonoriensis* was 122.2 mm and that for female *auricularis* was 119.2 mm (one-sided $p < 0.002$). Bills in male *sonoriensis* averaged 20.3 mm and those in male *auricularis* averaged 18.6 mm (one-sided $p < 0.0005$).

The southern samples were also darker than the northern. This darkening was not dramatic and taken alone does not constitute a good distinguishing character. Hargitt (1890:183) gives measurements of the type specimen of the nominate *auricularis* taken in Xautipa, Guerrero, as follows: culmen 23.5 mm, wing 117 mm, tail 72 mm, and tarsus 20.8 mm. These figures suggest that Hargitt's type may be placed with the southern samples. The northern samples representing material from Sonora to Colima may be recognized as a race distinct from the nominate being slightly lighter in coloration, and larger in some morphometric characters discussed earlier. These must be known as *Piculus auricularis sonoriensis* Van Rossem and Hachisuka. The nominate race is, therefore, restricted to Guerrero and Oaxaca as far south as Pochutla on the road to Puerto Angel from Oaxaca City.

Schaldach (1963) recorded the first specimens of this species for the state of Colima. The bird from Chihuahua reported herein (H.C. ♂ 4728) is believed to be the first record for that state. The material from Pochutla, Oaxaca (DM ♂ 25046, DM ♀ 25045, DM ♀ 38824) extends the range of the species from its former southern range in Guerrero (Miller et al. 1957). To date no specimens have been reported for the state of Michoacan.

The pine-oak forests of Jalisco continue on into Michoacan. However, a

belt of arid tropical scrub separates the Michoacan pine-oak forests from those in Guerrero (see map in Leopold 1959:16). *Piculus a. sonoriensis* is to be expected in Michoacan, but these populations are probably separated from those in the Sierra Madre del Sur (*auricularis*) by the xeric belt. It is conceivable, however, that if specimens from Michoacan are obtained, these may prove to be intermediate in size between the forms, in which case *sonoriensis* should be merged in *auricularis*.

Piculus auricularis AS A SUBSPECIES OF *P. rubiginosus*?

I found no evidence of interbreeding between *P. auricularis* and *P. r. yucatanensis* from which it seems to be separated by the Isthmus of Tehuantepec. Although previous authors have described *auricularis* as being entirely devoid of red on the crown, there were vestiges of red pigment on the tips of the crown feathers bordering the pileum in varying amounts on some specimens that I examined from throughout the species' range. Red spotting on the crown was described in a juvenile by Ridgway (1914) but is not necessarily limited to that age class. I interpret this as a recapitulation of an ancestral character indicating that *auricularis* is a derivative of the *rubiginosus* group to which it is similar in many other respects. An analogous situation may be found in the conure *Aratinga astec* which shows a tuft of orange feathering above the cere (Hardy 1966:66) suggesting a common ancestor with the orange-fronted *Aratinga canicularis*. I have never found a female of *Piculus auricularis*, however, showing any trace of red on the crown in contrast to females of the *rubiginosus* group which always have conspicuously red napes. The *rubiginosus* forms also have notably darker crowns than do *auricularis*. The pileum is slate-gray in the former and light-gray in the latter, although as a result of the color cline *auricularis* from the Sierra de Miahuatlan, Oaxaca, approach *yucatanensis* with regard to this character.

In some groups of birds, notably the parrots (Psittaciformes), small differences in color or color patterns are important in social recognition and may serve as effective isolating mechanisms between species (Hardy 1966, 1967). Experiments by Noble (1936) have demonstrated the importance of the malar stripe in sexual recognition of the common flicker. Jerome Jackson (pers. comm.) blackened the red nape patch on a male Downy Woodpecker (*Picoides pubescens*). Its mate treated the disguised male as another female and attacked it. Thus the presence (as in *Piculus rubiginosus*) or absence (*P. auricularis*) of a red nape patch may be an effective ethological isolating mechanism between the two forms should they ever prove to breed sympatrically.

Figs. 2–4 reveal a decreasing size cline from *sonoriensis* to *auricularis*;

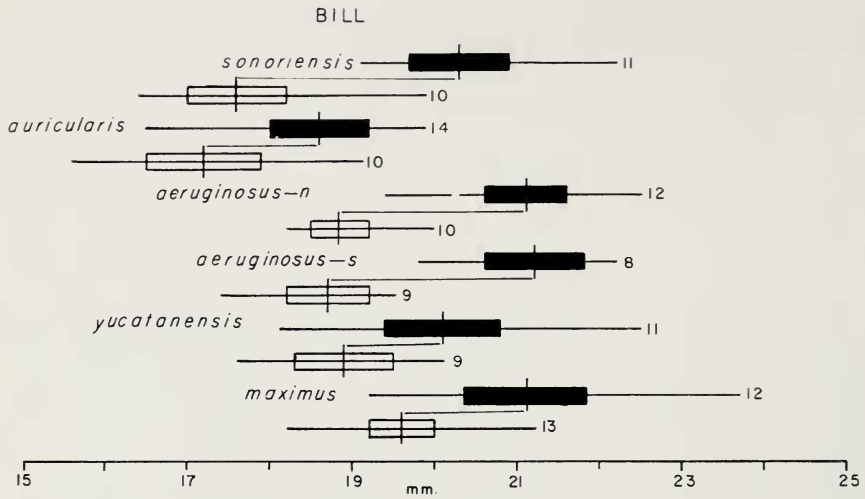

FIG. 2. Variation in bill length in Mexican *Piculus*. Horizontal lines denote ranges, vertical lines means, with rectangles as 95% confidence intervals on each side of the mean. Black rectangles denote males, clear rectangles signify females. Numbers indicate sample sizes. *Aeruginosus*-n = northern *aeruginosus* from Nuevo Leon, San Luis Potosi, and Tamaulipas, and *aeruginosus*-s = birds from Puebla and Veracruz.

however, with regard to measurements of bill and tarsus, this does not continue into *yucatanensis* which shifts to the right, i.e. toward larger values. The 2 complexes probably formed a continuous population down the west coast of Mexico at one time and are now separated by a belt of tropical deciduous forest (see map in Leopold 1959:16). Isolated from populations south of the Isthmus, and thus without the genetic load of eastern Mexican and Central American moister habitat populations, the accumulation of micromutations has resulted in the evolution of the northern population into its present form with overall lighter coloration (probably an adaptation to more xeric conditions) and in which selection against red on the crowns of females has been complete and is almost so in males. The available, indirect evidence, therefore, indicates that *Piculus auricularis* should be treated as a full species distinct from *rubiginosus*. This is in agreement with the Mexican check-list (Miller et al. 1957).

THE TAXONOMIC STATUS OF *Piculus aeruginosus*

Authors who have treated the form *aeruginosus* as a distinct species distinguished it from the *rubiginosus* complex, and in particular from the subspecies *yucatanensis* which replaces it geographically in central Veracruz, on the basis of the following characters:

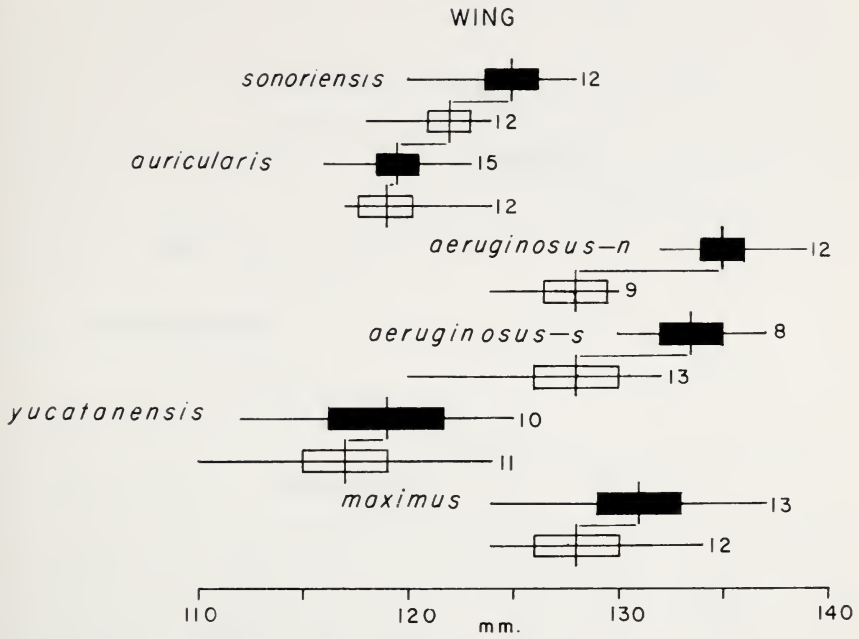

FIG. 3. Variation in wing length in Mexican *Piculus*. See Fig. 2 for explanation of figure.

(1) Whereas in *rubiginosus* red forms a complete border around the pileum (see frontispiece), it is "evanescent over the eye" in *aeruginosus* (Salvin and Godman 1892).
(2) The form *aeruginosus* is clear olive green on back, breast, and underparts, whereas *rubiginosus* is usually orange-olive in these areas.
(3) The form *rubiginosus* is banded below with narrow horizontal bands, whereas the transverse bands on the breast and belly of *aeruginosus* are wider and hastate or "V" shaped in pattern.
(4) The form *aeruginosus* is a larger bird than is *rubiginosus* (Blake 1953:290).

Similarities in *aeruginosus* and *rubiginosus* are (i) in color of pileum, the latter being slate-gray in both (Ridgway 1914, Blake 1953), and (ii) females of both forms are identical in head coloration, i.e. both have slate-gray pileums with red restricted to the nape region.

MENSURAL CHARACTERS

Males of *aeruginosus* average longer in bill length than *rubiginosus* (= *P. r. yucatanensis*) (Fig. 2), however, the difference is not statistically sig-

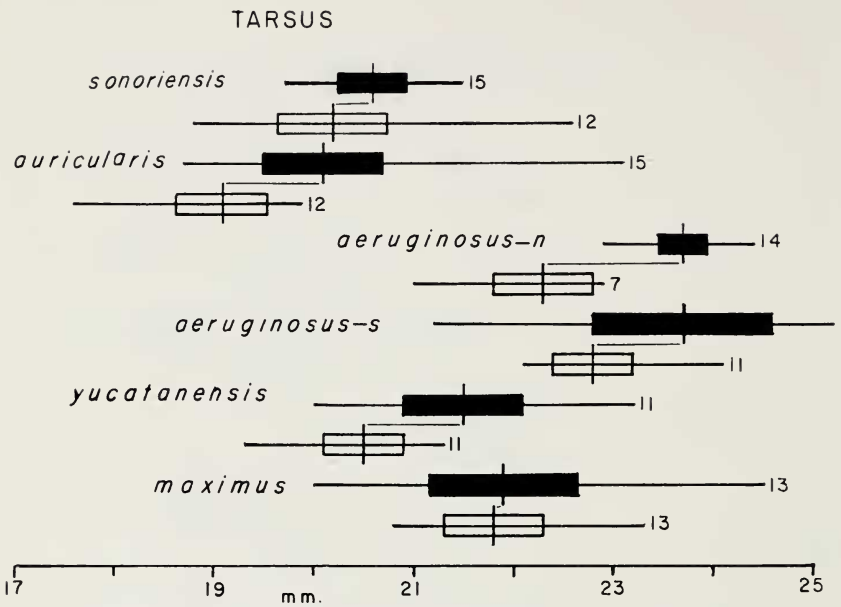

FIG. 4. Variation in tarsus length in Mexican *Piculus*. See Fig. 2 for explanation of figure.

nificant. Females of both forms have very similar bill lengths. Both sexes of *aeruginosus* are significantly larger in wing and tarsal length than *rubiginosus* (Figs. 3, 4). Although females of the 2 forms overlap in wing length, males do not. Although males of the 2 forms overlap in tarsus length, females do not. Males of northern *aeruginosus* (from Nuevo Leon, Tamaulipas, and San Luis Potosi) average longer in wing length than southern *aeruginosus* (from Puebla and Veracruz), but this difference is not statistically significant.

HEAD COLORATION

Hargitt (1890:82) described a male *aeruginosus* from "Atoyac, Mexico" with its crown color intermediate to the former and typical *rubiginosus* in having "red over the eye carried forward in a very narrow line to the base of the bill." Miller et al. (1957) refer to this specimen as having been taken in Atoyac, Guerrero. Although a locality by that name does exist in Guerrero, this would place it right in the middle of the range of *P. auricularis*. I think this is highly unlikely since no field investigators subsequent to Hargitt have reported *aeruginosus* for that state, yet several *auricularis* have been taken there. It is my belief that the Atoyac referred to is in fact near Orizaba in Veracruz (see Gazetteer in Loetscher 1959:19).

Lawrence Binford (pers. comm.) independently came to the same con-

clusion with different evidence. Along with *P. aeruginosus*, Binford found that the collector (Mrs. Smith) also collected *Celeus castaneus*, *Momotus lessoni*, *Trogon puella*, *Rhamphastos carinatos*, and other Atlantic species at Atoyac, making it unlikely that the latter is in Guerrero. I have examined Hargitt's (loc. cit.) specimen in the British Museum of Natural History (BM 98-3-10-130) and have since found 13 other individuals possessing crowns with various amounts of red intermediate to "typical" *aeruginosus* and *rubiginosus*. The following scoring system has been devised to describe variation in crown color:

Score

1. Red nuchal patch continuing to just behind or immediately over the eye ("typical" *aeruginosus*).
2. Red nuchal patch as in #1 but some small flecks of red in front of eye or over lore.
3. Red nuchal patch as in #1 but thin red line from above eye to the base of the bill [as in Hargitt's (1890) specimen].
4. Red nuchal patch with pileum conspicuously surrounded by red ("typical" *rubiginosus*).

Data on crown color are summarized in Table 1. Two of 3 males taken 48 km east of Huachinango, Puebla (9.5 km west from the Veracruz line) had intermediate (class 3) crowns. One male taken 4.75 km east of the road to Villa Juarez, Puebla, had a class 2 crown. One male taken at Presidio, 35 km south of Cordoba, Veracruz had an intermediate (class 3) crown. In all other characters it was typical of *rubiginosus*. Two other males taken 15.8 km away had crowns conspicuously surrounded with red; however, comparison with material taken farther south indicated that these 2 Veracruz males had less red surrounding the pileum than "typical" *rubiginosus*. Three other males from Veracruz with class 3 crowns included single individuals from Huatusco, Atoyac, and Tampico. Two males from Jalapa, Veracruz had class 2 crowns.

In addition to the intermediates taken in central Veracruz or the near vicinity, 5 other intermediates were examined from the more northern states. These include a male from Linares, Nuevo Leon (ML 42758) (crown class 2), 2 males from Rio Corona (ML 40289) and Ciudad Victoria, Tamaulipas (BM 98-3-10-124) (crown class 2), a male from above Ciudad Victoria, Tamaulipas (crown class 3) (BM 9-8-3-10-123), and a male taken 47.5 km east of Ciudad Maiz, San Luis Potosi (ML 32469) (crown class 2). A male taken 5 km north of Gomez Farias, Tamaulipas (HC 4586) has a class 3 crown.

TABLE 1

NUMBER OF SPECIMENS OF *AERUGINOSUS* AND VARIANTS SHOWING DIFFERENT CROWN COLOR STATES

State	Score			
	1	2	3	4
Nuevo Leon	4	1	0	0
Tamaulipas	6	2	2	0
San Luis Potosi	4	1	0	0
Puebla	1	0	2	0
Veracruz	7	3	4	3*

* Series taken near Presidio, Veracruz.

These data indicate that birds with crown classes intermediate to *aeruginosus* and *rubiginosus* may be found through the entire distributional range of *aeruginosus*.

BODY COLOR

I found the color of the back to be a good index of general body coloration. The following scoring system was devised to study variation in back color.

1. Clear olive green back (reference specimen ML ♀ 32473, Ciudad Maiz, San Luis Potosi).
2. Green back with a slight flush of yellow (reference specimen ML ♀ 54405, 27 km east of Tapanatepec, Chiapas).
3. Green back with darker yellow flush than #2. Sometimes darker orange tips to feathers of back (reference specimen ML ♀ 45499, Finca Cacahuatl 24 km northeast of Tapanatepec, Chiapas).
4. Orange-green back, darker than #3 (reference specimen ML ♂ 35271, Socoltenango, Chiapas).

Back classes 1 and 2 represent "typical" *aeruginosus* and back class 4 "typical" *rubiginosus* (= *P. r. yucatanensis*). Data on back scores are summarized in Table 2. It may be seen that in the northern parts of its range, *aeruginosus* tends to be lighter, whereas in the south it is darker.

A female *aeruginosus* from Papantla, Veracruz, had a back score of 3. Another female from Poza Rica was given a back score of 3 but tended towards a 2. A male from Puebla and a male from Linares, Nuevo Leon also had back scores of 3. Three of a series of 6 *rubiginosus* taken at Presidio, Veracruz and 3 birds from Tenozapa, Veracruz had back scores of 3. Thus, in central Veracruz and nearby Puebla, individuals of the form *aeruginosus* may be similar in back color to some individuals of *rubiginosus*. Moreover,

TABLE 2

BACK COLOR IN *AERUGINOSUS* AND *YUCATANENSIS*

State	Score			
	1	2	3	4
Nuevo Leon	5	0	1	0
Tamaulipas	10	1	0	0
San Luis Potosi	10	0	0	0
Puebla	0	5	1	0
Veracruz-1	1	11	2	0
Veracruz-2*	0	0	3	4

* "Pure" *yucatanensis* from contact areas.

the darker *rubiginosus*-like back (class 3) appeared as far north as Nuevo Leon.

PATTERN OF BARRING ON BREAST AND BELLY

The proportion of hastate spotting to barring and the width of the bars on breast, belly, and sides vary greatly in *aeruginosus*. The following 3 point scoring system was devised to study pattern of barring on the undersides of *aeruginosus*.

1. V or U shaped bands on entire breast, upper parts of belly, and sides (reference specimen ML ♀ 42961, Linares, Nuevo Leon, see Fig. 5).
2. V or U shaped bands restricted to upper breast. Lower breast and all or almost all of belly and sides with horizontal bands. Yellow bands often narrower than in #1 (reference specimen ML ♂ 32469, Ciudad Maiz, San Luis Potosi).
3. Horizontal bands on entire breast, belly, and sides. Yellow bands as narrow or narrower than in #2 (reference specimen ♂ 51606, Huatusco, Veracruz.

Barring class 3 represents the condition in "pure" *rubiginosus* (= *P. r. yucatanensis*). Barring class 2 represents the intermediate form, and class 1 the "pure" *aeruginosus*. In class 1 the pattern on the underside gives one the impression of yellow spots or scales. Sometimes the shapes of the bars in breast types 1 and 2 are similar to those in *Piculus auricularis*, a fact noted earlier by Salvin and Godman (1889). Bars in *auricularis* are horizontal, each band divided in the center by a very small V. Banding scores are summarized in Table 3.

A male taken at Huatusco, Veracruz (ML 51606) was light green on the back (back score 2) with red stopping behind the eye, characters of *aerugi-*

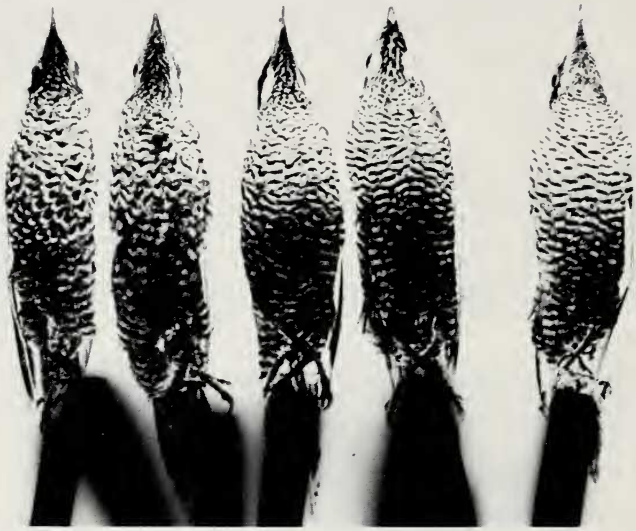

FIG. 5. This is a negative print to emphasize barring patterns on skins of *yucatanensis*, *aeruginosus*, and variants. From left to right: 1. ML ♀ 34809, typical *aeruginosus*, taken 30 miles east of Huachinango, Puebla. 2. ML ♂ 40613, typical *aeruginosus*, taken at Rio Corona, 18 miles north of Ciudad Victoria, Tamaulipas. 3. ML ♂ 32469, variant *aeruginosus* with horizontal bars intermixed with hastate patterning, taken 30 miles east of Ciudad Maiz, San Luis Potosi. 4. ML ♂ 51606, variant *aeruginosus* completely barred below as in *yucatanensis*, taken 9 miles south of Huatusco, Veracruz, Mexico. 5. ML ♀ 45492, typical *maximus* for comparison, taken 15 miles northeast of Tapanatepec, Chiapas, Mexico.

nosus. It was, however, indistinguishable in banding pattern from pure *rubiginosus*.

A female taken at Jalapa, Veracruz (AM44069) was almost entirely barred below with horizontal (*rubiginosus*) bands. Only a few very small U-shaped spots on its upper breast indicate some *aeruginosus* ancestry. It was, however, *aeruginosus* green (back score 2) on its back. A similar female taken at Cordoba, Veracruz, is in the collection of the British Museum of Natural History (BM 1857-7-30-4). It was taken with a male bearing the hastate markings of a "pure" *aeruginosus* (BM 1857-7-30-5) on the breast with the belly by degrees coming close to *rubiginosus*-type barring (Goodwin in litt.). A male taken at La Gloria, 15.8 km northwest of Presidio, Veracruz, (1 of a series of 3 males and 1 female) had a banding pattern reminiscent of *aeruginosus* in being almost scale-like. The other 3 birds had typical *rubiginosus* horizontal bands.

TABLE 3

BANDING PATTERN IN BREAST AND BELLY ON *AERUGINOSUS*

State	Score		
	1	2	3
Nuevo Leon	6	0	0
Tamaulipas	10	1	0
San Luis Potosi	7	3	0
Puebla	2	5	0
Veracruz	10	3	3

It is clear that individuals with banding patterns intermediate to *aeruginosus* and *rubiginosus* (Table 3) may be found in all but one state, Nuevo Leon. Moreover, 3 individuals had banding patterns indistinguishable from "pure" *rubiginosus*.

Ridgway (1914) records both *rubiginosus* and *aeruginosus* from Mount Orizaba. He also reports an *aeruginosus* from Cordoba, Veracruz: a variant described above was taken 55.4 km from this town. Additional variants taken at Cordoba in the collection of the British Museum have been described earlier. Lowery (1951) reports taking an *aeruginosus* at Portrero Viejo, 31.6 km from Presidio, Veracruz. I have described variant and "pure" *rubiginosus* taken 15.8 km from Presidio. Specimens showing characters typical or intermediate to both forms in various combinations have been found throughout the range of *aeruginosus* (Tables 1–3). This suggests that the latter has not differentiated completely from *rubiginosus* and must be regarded as a race of this species following Miller et al. (1957).

VARIATION IN *P. r. yucatanensis* AND *P. r. maximus*

Griscom (1929) described the race *maximus* from Guatemala as a larger bird than *yucatanensis* and greener throughout, lacking the "golden brown wash" of the latter race. Miller et al. (1957) included *maximus* in the Mexican check-list restricting its range in Mexico to the Pacific slope of extreme southeastern Oaxaca and adjacent Chiapas highlands at moderate altitudes.

P. r. maximus is separable from *yucatanensis* on the basis of wing length in both sexes (Fig. 3). Wing length in male *maximus* averaged 130.8 mm and that in *yucatanensis* averaged 119.2 mm (one-sided $p < 0.00005$). Mean wing length in female *maximus* was 128.1 mm and that in female *yucatanensis* was 117.0 mm (one-sided $p < 0.00005$).

Yucatanensis are highly variable in coloration. The same 4-point scoring system used to study color variation in *aeruginosus* was used to study color variation in *yucatanensis* and *maximus* (Table 4). Back color was again

Table 4

Back Color in *YUCATANENSIS* and *MAXIMUS*

		Color Score						
	N	1	1–2	2	2–3	3	3–4	4
yucatanensis	35	0	0	1	4	7	6	17
maximus	56	0	0	15	7	24	6	4

taken as a rough index of general body color. A score of 4 indicated a typical *yucatanensis* and a score of 3 or less a typical *maximus*.

The difference in color scores (Table 4) between my large-winged samples and my small-winged samples is significant ($p < 0.0001$, Wilcoxon). However, since there is a great overlap in scores, color alone is not a good character to separate the races.

Presidio, Tenozapa, and La Gloria, Veracruz are in the vicinity of the zone of contact between *yucatanensis* and *aeruginosus*. Six lighter birds from these localities (scores 3 or tending towards 2, Table 4) may be indicative of introgression of *aeruginosus* genes. Similarly, a light bird from Comitan (1 of 4) may reflect some *maximus* genes. However, 5 lighter colored birds from Catemaco, Matias Romero, and Tumbala (scores 2 to 3) are probably illustrative of the erratic type of color variation in *yucatanensis* remarked on by Griscom (1929).

One *maximus* from near Tapanatepec, Chiapas (scores 3–4) and 2 dark birds from Socoltenango (Table 4) may reflect some *yucatanensis* ancestry. However, 1 dark bird from Cacahuatan and 1 from Pijijiapan (scores 3–4 to 4) are probably erratic variants as discussed above.

Howell (1952) noted that red pigment in sapsuckers (*Sphyrapicus*) is restricted to the tips of their feathers, a fact applying also to *Piculus*. Griscom (1929) found that the feathers of the back in males may sometimes be red-tipped. I observed this occasionally, e.g. in a female from Catemaco, Veracruz and a male from Las Palmitas, Honduras. Red may also invade the top of the pileum in various degrees. These observations suggest that the *P. rubiginosus* complex shared a common ancestor with *Piculus rivoli*; the latter as a red-backed species variable in the amount of this pigment on the pileum and back and with patterns below suggesting *rubiginosus*.

SIZE DIMORPHISM BETWEEN THE SEXES

Size dimorphism between the sexes was computed as percent difference in mensural characters between males and females and coefficient of difference (Mayr et al. 1953).

TABLE 5

SEXUAL DIMORPHISM IN *PICULUS*

	%	c.d.	% joint nonoverlap
BILL			
sonoriensis	15.4	1.3	91
auricularis	8.5	0.65	<75
aeruginosus-N	12.1	1.3	91
aeruginosus-S	13.2	1.5	94
yucatanensis	6.2	0.55	—
maximus	7.4	0.70	<75
WING			
sonoriensis	2.3	0.67	75
auricularis	0.18	0.04	—
aeruginosus-N	5.6	1.5	94
aeruginosus-S	4.3	0.99	84
yucatanensis	1.8	0.47	—
maximus	2.1	0.38	—
TARSUS			
sonoriensis	2.2	0.35	—
auricularis	5.5	0.38	—
aeruginosus-N	5.5	1.1	87
aeruginosus-S	4.2	0.47	—
yucatanensis	3.3	0.32	—
maximus	0.6	—	—

All samples are most dimorphic in bill length, as evidenced by percent difference in measurements and percent of joint nonoverlap (Table 5). Only in *yucatanensis* is dimorphism in bill length not significant. There is also a reduction in dimorphism from north to south, i.e from *sonoriensis* to *auricularis* and from *aeruginosus* to *yucatanensis*. The difference in dimorphism between northern and southern samples of *aeruginosus* is small and probably due to sample error.

There is also a north to south reduction of dimorphism in wing length, from *sonoriensis* to *auricularis* and from *aeruginosus* to *yucatanensis*. The slight north to south reduction in dimorphism between the samples of *aeruginosus* is due to the slight north to south decrease in wing length in male *aeruginosus*.

Only northern *aeruginosus* are dimorphic in tarsus length. This again may be due to sample error.

Davis (1965:566) has suggested that "the evolution of accentuated sexual

dimorphism in a given character is one means of increasing the variability of the character in the population. But another method would be the evolution of accentuated individual variability within each sex in the character concerned, with presumed increased variability in diet." Selander (1966) interprets dimorphism, especially in bill length, as adaptive radiation at the intra-populational level so that individuals may "occupy different subniches or adaptive subzones, subdividing and, perhaps, expanding the total zone or niche" used by the population. Kilham (1965), Selander (1966), and others (review in Hogstad 1976) have studied a variety of woodpecker species and found that either each sex fed on different species of trees, employed different methods of foraging, or fed on different portions of the same tree. However, Ligon (1968) studied Red-cockaded Woodpeckers (*Picoides borealis*) which were only slightly sexually dimorphic for bill size and found differences in foraging sites between the sexes. Subsequently, Ligon (1973) studied White-headed Woodpeckers (*P. albolarvatus*) with greater dimorphism in bill length (10%) than any other measurement and found no differences in foraging sites between the sexes. He cautioned, therefore, (Ligon 1973:867) that one cannot always predict foraging patterns by degree of sexual dimorphism in bill size. The Mexican forms of *Piculus* differ greatly in degree of sexual dimorphism in bill size, from 15.4% in *sonoriensis* or 13.2% in *aeruginosus* to almost none in *yucatanensis*. It is hoped that these data will encourage others to conduct ecological studies on this little known group.

DISCUSSION

In this treatment, all taxa of *Piculus* proposed in the Mexican check-list (Miller et al. 1957) are recognized, with, however, differences in the ranges of the subspecies of *P. auricularis* (Fig. 1). The western *auricularis* complex has been described as paler than the *rubiginosus* forms of the east and southeast. Buchanan (1964) has observed a similar situation for Least Pygmy Owls (*Glaucidium minutissimum*). This trend could probably also be found in other Mexican birds with similar distribution ranges.

Size decreases clinally from north to south (Figs. 2–4), i.e. from *sonoriensis* to *auricularis* and from *aeruginosus* to *yucatanensis*, a manifestation of Bergmann's rule (Mayr 1942, James 1970, Mengel and Jackson 1977). The clines are steeper for males than they are for females for wing and bill length.

The tendency towards darker individuals in the southern parts of the ranges of both the *auricularis* and *rubiginosus* complexes is a manifestation of Gloger's rule (Mayr 1942). Gloger's rule may also be interpreted as the result of selection for crypticity. Selander and Giller (1963) discuss the color patterns found in *Melanerpes aurifrons*, pointing out

that "Boldly patterned types (*M. a. aurifrons* and *M. a. polygrammus*), which are in gross aspect much lighter than the narrowly barred types (*M. a. dubius* and *M. a. santacruzi*), are found in arid regions where light penetrates deep into the middle and lower strata of relatively open woodland vegetation, and the background of trunks and branches to which the woodpeckers are exposed is relatively light in color. But in more humid regions where denser broad-leaved vegetation creates greater areas of shadow and where the color of the vegetation tends to be darker, the dark appearance of the narrowly barred form is probably at a selective advantage. In similar fashion we assume that the value and hue of the color of the breast and sides are adaptive, providing effective counter-shading by being darker in more humid areas and lighter in those of greater aridity." Concommitant with color changes in the *Piculus* forms mentioned are also changes in the vegetation types as shown in Leopold's (1959) vegetation map of Mexico. In Chiapas both Bergmann's and Gloger's rules operate locally to produce the larger, lighter race *maximus* of the montane districts of the Pacific Cordillera and the smaller darker race *yucatanensis* of the Atlantic lowlands.

I have discussed the results of selection against red pigment on the crowns of *aeruginosus* and *auricularis*. This perhaps may be interpreted as selection for increased crypticity in areas of more open vegetation where bright colors would render them more conspicuous. It is noteworthy that in none of the forms is the red of the male malar stripes in any way affected. Noble (1936) has shown the importance of such malar stripes in sexual recognition in the Common Flicker (*Colaptes auratus*). It is probably because of a similarly important role as a social releaser that these stripes are retained in *auricularis* and *aeruginosus*.

SUMMARY

Variation in the Mexican representatives of the genus *Piculus* was studied in order to determine the status of the described forms (species and subspecies). A qualitative analysis of museum specimens representing population samples was presented along with quantitative data including statistical treatments of bill, wing, and tarsus measurements.

The status of *Piculus auricularis sonoriensis* Van Rossem and Hachisuka was discussed: the type and a topotype examined did not differ from samples taken in neighboring states as indicated by the authors. However, northern samples of *Piculus auricularis* from Sonora to Colima were separable from material from Guerrero and Oaxaca on the basis of size and color. Two races are thus recognized.

Variation in *Piculus aeruginosus* Malherbe was studied and evidence was presented suggesting genetic continuity and introgression with *P. r. yucatanensis* so that it is here regarded as a race of *rubiginosus*. Two races of *Piculus rubiginosus* are recognized for Chiapas, *maximus* of the Pacific Cordillera and *yucatanensis* of the Atlantic lowlands, separable on the basis of coloration and wing length.

All the forms of *Piculus* in the Mexican check-list (Miller et al. 1957) are thus recog-

nized with some changes in geographic distribution; these were divided into 2 species complexes including the gray crowned *auricularis* forms occupying the more xeric west and the slate crowned *rubiginosus* races of the more mesic east and southeast. In *aeruginosus* and *auricularis* size decreased clinally from north to south and intensity of coloration was found to increase in a clinal fashion in the same direction in accordance with Gloger's rule. Manifestation of Gloger's rule was discussed as being possibly the result of selection for crypticity. Both laws seem to operate locally in Chiapas to produce the larger, lighter colored highland race *maximus*.

Size dimorphism between the sexes was found to decrease from north to south in both species complexes. Size dimorphism was most pronounced in bill length in all but one form (*yucatanensis*). The possible ecological significance of these findings was discussed.

ACKNOWLEDGMENTS

My thanks first of all to Robert T. Orr who called my attention to this problem, and for all his advice and assistance in the preparation of this paper; to Jacqueline Schonewald and my wife, Joyce, for their help and advice in the statistical methods; to Jerome A. Jackson, Ned K. Johnson, Edward Kessel, Lloyd Kiff, David Mullen, Robert T. Orr, and Lester L. Short for reading various versions of this manuscript and for their valuable suggestions; to the late Elwood Molseed for providing transportation to Mexico City where I examined some critical material and for his delightful companionship in the field.

My thanks also to the following institutions and individuals for the loan of material which made this study possible and for courtesies extended to me during my visits to some of these institutions: The American Museum of Natural History (AM) (L. L. Short), the Allan Phillips Collection at the Instituto de Biologia in Mexico City (DM) (A. R. Phillips, B. Villa, A. Villalobos), the Western Foundation of Vertebrate Zoology (HC) (E. Harrison, L. Kiff, and the late J. S. Rowley), the Dickey Collection at the University of California, Los Angeles (UCLA) (G. Bartholomew, T. Howell, H. Pough and C. Rischer), the Robert T. Moore Collection at Occidental College (ML) (J. W. Hardy), Louisiana State University (LSU) (G. Lowery), the Museum of Zoology, University of Michigan (MU) (R. W. Storer), the Museum of Vertebrate Zoology, University of California, Berkeley (MVZ) (N. K. Johnson), the British Museum of Natural History (BM) (D. Goodwin), and the Delaware Natural History Museum (DM) (D. M. Niles).

A grant from the California Academy of Sciences enabled me to do some field work in the Sierra de Miahuatlan in Oaxaca in the summer of 1965. In the summer of 1966 an additional grant from the California Academy of Sciences and the courtesy of Dr. Elwood Molseed permitted more field work in Mexico and the visit to Dr. Allan Phillips' collection. A grant from the American Association for the Advancement of Sciences enabled me to visit the institutions in Southern California listed above. For making these grants available to me, my sincerest thanks to Drs. Robert T. Orr and George E. Lindsay.

Last but not least, I thank Dr. George M. Sutton for the beautiful colored plate which adds much to this paper.

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